3.5 Geology, Soils, Faulting and Seismicity

This section evaluates whether construction and operation of the proposed project would result in potential adverse impacts related to local geology, existing soil conditions, or seismicity. The evaluation and analysis of geology, soils, faulting and seismicity are based, in part, on review of various geologic maps and reports. The primary sources include the *Perris Dam Foundation Study* and the *Perris Dam Reconnaissance Study*. The geologic and geotechnical evaluation of the proposed project also included review of available geologic maps, resources, geotechnical studies, and subsurface boring data.

3.5.1 Setting

Regional Geology

The project area lies within the geologically complex region of Southern California referred to as the Peninsular Ranges geomorphic province.[1] The Peninsular Ranges province lies in the southwestern-most tip of California with the Transverse Range province to the north, the Colorado Desert province to the east, and the Pacific Ocean to the west. The topography of the province is similar to the Coast Ranges with alternating northwest trending ridges and valleys but the geology more closely resembles the Sierra Nevada with granitic intrusions into older metamorphic rocks (CGS, 2002a).

The project site is located between the northwest trending Perris and San Jacinto Valleys surrounded by the Bernasconi Hills to the south and the Russell Mountains to the north. Lake Perris covers a large portion of the valley floor within the surrounding ridges characterized by weathered granitic bedrock (Kgr) of variable thickness that is overlain by alluvial deposits at lower elevations (DWR, 2005). The weathered bedrock becomes fresh and more competent with depth.

The current dam embankment is founded mostly on native alluvial soils (Qal) deposited in the valley floor. These deposits consist of stream and slope wash deposits that originated from the weathering of nearby granitic rocks. The alluvium typically ranges in thickness from 0 to 150 feet throughout the reservoir and dam site area except for an area beneath the left reach of the dam where a deep paleo-channel occupies a topographic low in the granitic bedrock. The alluvium in this paleo-channel attains a thickness of as much as 290 feet. The alluvium (Qal) consists primarily of Silty Sands (SM) and Clayey Sands (SC) with lenses of Poorly Graded Sands (SP-SM) and minor amounts of gravel. In general, the coarser grained materials are found upstream from the dam axis and toward the abutments where the slope gradients increase. The full dam alignment is divided into two segments by a granitic outcrop referred to as the mid-abutment area.

The alluvium (Qal) also contained lenses of isolated, near surface cemented fine-grained Silty Sands (SM) across the valley floor colloquially referred to as “hardpan.” The hardpan was less

1 A geomorphic province is an area that possesses similar bedrock, structure, history, and age. California has 11 geomorphic provinces (CGS, 2002a).

frequently encountered in more recent subsurface explorations and likely may have gone into solution by 30 years of saturation from the reservoir.

The stability berm would be constructed mostly from materials excavated from the borrow area located at the east end of the lake and from the existing rock quarry located east of the left abutment in the Bernasconi Hills. The soils from the borrow area at the east end of the lake consist of recent lake deposits up to about a foot thick overlying the alluvial sediments that would be inundated when the reservoir level is returned to a normal reservoir operating elevation of 1588 feet. The hard rock from the present level of the quarry consists of mostly slightly weathered to fresh granitic bedrock.

Topography

The topography within the region is dominated by the semi-circular ridge of bedrock surrounding the reservoir which includes Mt. Russell and the Bernasconi Hills. The lowest elevations occur downstream of the dam at approximately 1480 feet below mean sea level (msl). The Bernasconi Hills reach an elevation of 2589 at their highest and Mt. Russell peaks at 2704 feet amsl. The normal operating level of the dam is 1588 feet amsl which is 108 feet above the reservoir floor (WGI, 2006). Southwest of the dam embankment several granitic rock outcrops rise above the valley floor, the highest of which has an elevation of 1704 feet amsl. The dam crest is at an elevation of 1,600 feet (not including camber) amsl and approximately 40 feet wide. The downstream face is at a slope of approximately three horizontal to one vertical (3H:1V) whereas the upstream face is at 4H:1V. A 10-foot wide service road bench is cut into the downstream face near the toe of the dam.

Soils

The U.S. Department of Agriculture (USDA) Soil Conservation Service has never mapped the area surrounding the project site. However, information obtained from DWR prior to construction of the dam indicates that the reservoir was predominantly underlain by buried stream channel deposits (DWR, 1975 as referenced in DWR, 2005). The stream deposits consisted of sands, silts, and gravels.

Seismicity

Southern California is a region of high seismic activity with numerous active and potentially active faults.[2] Major earthquakes have affected the region in the past and can be expected to occur again in the near future on one of the principal active faults in the San Andreas Fault System. The principal active faults in the region include the San Andreas, San Jacinto and Elsinore faults.

2 An *active* fault is defined by the California Geological Survey is a fault that has had surface displacement within Holocene time (approximately the last 11,000 years). A *potentially active* fault is a fault that has shown evidence of surface displacement during the last 1.6 million years, unless direct geologic evidence demonstrates inactivity for the last 11,000 years or longer. This definition does not mean that faults lacking evidence of surface displacement are necessarily inactive. *Sufficiently active* is also used to describe a fault if there is some evidence that Holocene surface displacement occurred on one or more of its segments or branches (Hart, 1997).

Richter magnitude (M) is a measure of the size of an earthquake as recorded by a seismograph, the standard instrument that records ground shaking. The reported Richter magnitude for an earthquake represents the highest amplitude measured by the seismograph at a distance of 100 kilometers from the epicenter. Richter magnitudes vary logarithmically, with each whole number step representing a tenfold increase in the amplitude of the recorded seismic waves. Earthquake magnitudes are also measured by their moment magnitude (Mw), which is related to the physical characteristics of a fault, including the rigidity of the rock, the size of fault rupture, and the movement or displacement across a fault (CGS, 2002b).

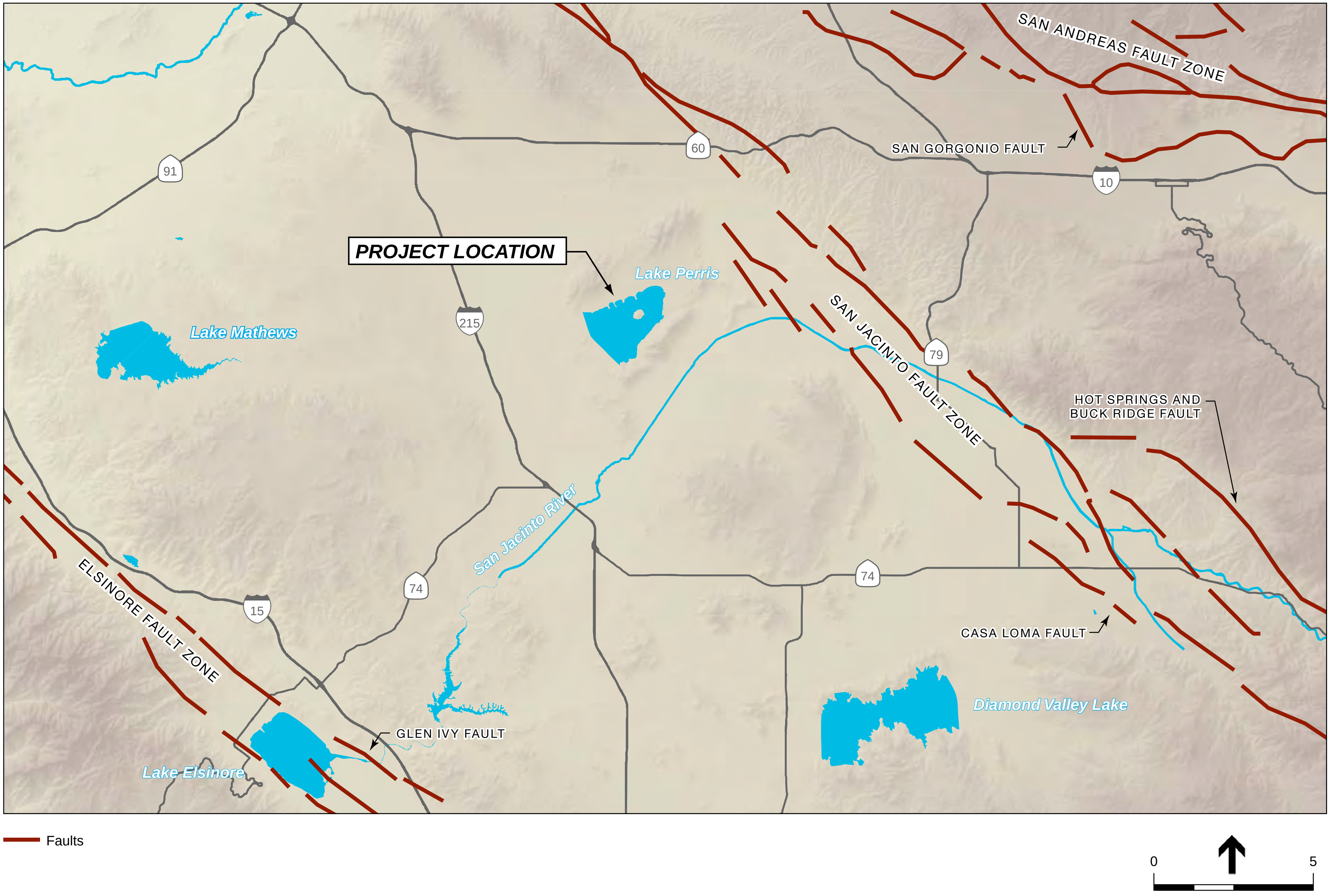
The project site is located seismically within what is known as the Perris structural block. The Perris block is bound by the San Jacinto fault to the east, the Elsinore fault to the west, trends of the Red Hill and San Jose faults to the north, and a trend of the Murrieta Hot Springs fault to the south (DWR, 2005) (**Figure 3.5-1**). A number of these faults, such as the San Andreas, San Jacinto, and Elsinore, have experienced significant seismic activity during historic time (within the last 200 years).

Table 3.5-1 lists the location of regionally active faults and potentially active faults significant to the project area due to proximity, activity status, date of most recent motion, and maximum moment magnitude (Mmax). The Mmax is the strongest earthquake that is likely to be generated along a fault and is based on empirical relationships of surface rupture length, rupture area, and fault type, which are all related to the physical size of fault rupture and displacement across a fault.

The San Jacinto fault is the most seismically active fault in Southern California (Treiman, 2007a). The San Jacinto fault is also the closest active fault to the dam at approximately 5 miles to the northeast. Significant earthquakes have occurred on various segments of the fault, which is over 100 miles long, in 1987 (M 6.6) and 1967 (M 6.6) in addition to earthquakes that occurred prior to the advent of measuring devices in 1899 and 1918 (Treiman, 2007a).

The largest historic earthquake to affect the area occurred on the San Andreas fault, located approximately 17 miles northeast from the project site. The 1857 Fort Tejon earthquake was estimated at M 7.9 and caused surface rupture along the fault for 225 miles. The 1857 earthquake along with the 1906 San Francisco earthquake represent the two largest fault ruptures in historic time. The southernmost fault rupture associated with the 1857 event occurred within 35 to 40 miles of the project site near Cajon Pass (DWR, 2005).

The Elsinore fault is located approximately 14 miles southwest of the project site. Multiple earthquake events have been identified only on the northern segments of the fault so the interactions of the various strands are not well known (Treiman, 2007b). Historical record indicates that a large earthquake occurred on the Elsinore fault in 1910 at an estimated magnitude of 6.0 (DWR, 2005). However, compared to the San Jacinto, the historic activity on the Elsinore fault has been relatively low.



SOURCE: Riverside County, 2007.

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Figure 3.5-1
Regional Faults

TABLE 3.5-1
ACTIVE FAULTS IN THE PROJECT VICINITY

Fault	Location and Direction from Project Site	Recency of Movement	Fault Classification[a]	Historical Seismicity[b]	Maximum Moment Magnitude Earthquake (Mmax)[c]
San Jacinto (including the Casa Loma Segment)	5 miles northeast	Historic (historic rupture)	Active	M 6.6 1987, M6.6 1968 Many >M6.0	7.2
San Andreas	17 miles northeast	Historic (1906N, 1989N, 1857S ruptures)	Active	M 7.9 1857 M 7.1, 1989 M 7.9, 1906 M 7.0, 1838 Many >M 6.0	8.0
Elsinore	20 miles southeast	Historic (1861 rupture) Holocene	Active	M 6.0, 1910	7.1

[a] Jennings, 1994, and Hart, 1997. An active fault is defined by the California Geological Survey as one that has had surface displacement within approximately the last 11,000 years. A potentially active fault is defined as a fault that has showed evidence of surface displacement during approximately the last 1.6 million years.
[b] Richter magnitude (M) and year for recent and/or large events. Richter magnitude scale reflects the maximum amplitude of a seismic wave measured at a distance of 100 kilometers from the epicenter.
[c] Moment magnitude is related to the physical size of a fault rupture and movement across a fault. The maximum moment magnitude (Mmax) is the strongest earthquake that is likely to be generated along a fault and is based on empirical relationships of surface rupture length, rupture area, and fault type.
N=Northern
S=Southern

SOURCES: Jennings, 1994; Hart, 1997; DWR, 2005, Treiman, 2007a and 2007b.

No other active faults are present in the vicinity of the project site. Old bedrock shear zones have been observed within the project area; however these are thought to be the result of granitic intrusion rather than seismic activity (DWR, 2005). Otherwise the Perris block is virtually devoid of significant seismicity when compared to other surrounding areas (DWR, 2005).

Seismic Hazards

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake’s seismic waves. The magnitude and nature of fault rupture can vary for different faults, or even along different strands of the same fault. Ground rupture is considered most likely along active faults.

The project site is not located within an Alquist-Priolo Earthquake Fault Zone, as designated by the Alquist-Priolo Earthquake Fault Zoning Act, and no mapped active faults are known to pass through the immediate project region. Therefore, the risk of ground rupture at the project site is extremely low.

Ground Shaking

Earthquakes in the Southern California region could produce strong ground shaking in the project vicinity and represent the most severe loading most dams could experience (Fraser, 2001). Ground shaking intensity is partly related to the size of an earthquake, the distance to the site, and the response of the geologic materials that underlie a site. As a rule, the greater the earthquake magnitude and the closer the fault rupture to a site, the greater the intensity of ground shaking. Violent ground shaking is generally expected at and near the epicenter of a large earthquake; however, different types of geologic materials respond differently to earthquake waves. For instance, deep unconsolidated materials can amplify earthquake waves and cause longer periods of ground shaking.

Ground motion during an earthquake can be described using the motion parameters of acceleration, velocity, and duration of shaking. A common measure of ground motion is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal acceleration obtained from a seismograph. PGA is expressed as the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. For comparison purposes, the maximum peak acceleration value recorded during the Loma Prieta earthquake (San Andreas fault) was in the vicinity of the epicenter, near Santa Cruz, at 0.64 g. The lowest recorded value was 0.06 g in the bedrock on Yerba Buena Island. However, an earthquake on the San Jacinto fault could produce more severe ground shaking at the project site. According to estimates made by the CGS, the peak ground acceleration at the site could reach up to 0.70 g (CGS, 2007b).[3] This calculation is based on what was determined to be the maximum credible earthquake (MCE)[4] on the San Jacinto fault, with a Mw of 7.5 at a distance of approximately 5 miles from the site (DWR, 2005). A deterministic analysis of potential groundshaking at the project site concluded that the PGA at the proposed site, more specifically at the crest of the dam, could reach 0.78g (DWR, 2005).[5]

Secondary Earthquake Hazards

Secondary earthquake hazards at the project site include earthquake-induced land sliding, settlement, and liquefaction. Strong ground motions that occur during earthquakes are capable of inducing landslides and related forms of ground failure. Settlement is the gradual downward

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3 A probabilistic seismic hazard map shows the predicted level of hazard from earthquakes that seismologists and geologist believe could occur. The map’s analysis takes into consideration uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site. The maps are typically expressed in terms of probability of exceeding a certain ground motion. These maps depict a 10% probability of being exceeded in 50 years. There is a 90% chance that these ground motions will NOT be exceeded. This probability level allows engineers to design buildings for larger ground motions than seismologists think will occur during a 50-year interval, making buildings safer than if they were only designed for the ground motions that are expected to occur in the 50 years. Seismic shaking maps are prepared using consensus information on historical earthquakes and faults. These levels of ground shaking are used primarily for formulating building codes and for designing buildings. (CGS, 2007a)

4 The MCE is the largest earthquake reasonably capable of occurring based on current geological knowledge. The MCE is used for design purposes in a deterministic seismic hazard assessment.

5 This PGA value was determined using what is known as a deterministic seismic hazard assessment approach. First, the faults nearest a site are identified and assessed for activity, then for each seismic source, an earthquake scenario consisting of the maximum magnitude a fault is capable of generating at the closest distance to the site is used to determine the ground motion estimate. A deterministic seismic hazard analysis is time-independent and does not represent the likelihood of such an event occurring within a given time frame (Fraser, 2001).

movement of an engineered structure (such as a building) due to the compaction of unconsolidated material below the foundation. Settlement accelerated by earthquakes can result in vertical or horizontal separations of structures or portions of one structure; cracked foundations, roads, sidewalks, and walls; and (in severe situations) building collapse and bending or breaking of underground utility lines. Soil liquefaction, a phenomenon in which soils lose significant strength due to cyclic shaking, can result in ground failure. The soils most susceptible to liquefaction are clean, loose, uniformly graded, saturated, sands, and silts. In general, upland areas have a low liquefaction potential, except where significant alluvium is present in creek bottoms or swales.

The potential for excessive embankment deformations as a result of seismically induced liquefaction of the foundation soils were found to be present at the project site. The area found to be the most susceptible was a 2,300-foot long portion of the left reach of the dam. The static analyses considered stability of the embankment during and immediately following a ground-shaking event. The dynamic analyses predicted permanent horizontal displacements to exceed 30 feet and the estimated vertical displacements 15 feet. Even in the event the predicted displacements were smaller, the potential for significant cracking was also recognized which could lead to failure due to the brittle nature of the embankment materials.

Other Geologic Hazards

Landslides and Slope Failure

Ground failure is dependent on the slope and geology as well as the amount of rainfall, human activities such as excavation, or seismic activity. A slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Landslide-susceptible areas are characterized by steep slopes and downslope creep of surface materials. Debris flows consist of a loose mass of rocks and other granular material that, if saturated and present on a slope, can move downslope.

The rate of rock and soil movements can vary from a slow creep over many years to a sudden mass movement. Landslides occur throughout California, but the density of incidents increases in zones of active faulting. At the project site, there is a potential for slope failures occurring mainly as rockfalls within the existing rock quarry as well as the surrounding upland areas.

3.5.2 Regulatory Framework

State

Division of Safety of Dams

Since 1929, California has supervised the construction and operation of dams to prevent failure, safeguard life and protect property. The California Department of Water Resources, Division of Safety of Dams (DSOD) oversees the construction, enlargement, alteration, repair, maintenance, operation, and removal of dams and reservoirs. The DSOD has jurisdiction over all non-Federal dams in the State that are 25 feet or higher (regardless of storage capacity) and dams with a storage capacity of 50 af of water or greater (regardless of height). Dams six feet or less in height (regardless of storage capacity) or dams with a storage capacity of 15 af or less (regardless of height) are not under DSOD jurisdiction.

The DSOD reviews permit applications to evaluate the safety of dams and reservoirs. DSOD staff provides independent review of facilities design and safety calculations. The DSOD requires the collection of data concerning subsoils, foundation conditions, availability of construction materials, and geologic hazards to assess the potential for seepage, earth movement, and other conditions that may occur in the vicinity of a dam or reservoir. Investigations usually include exploratory pits, trenches, drilling including hydraulic conductivity testing, geophysical surveys, and physical tests to measure properties of foundation materials. During construction or repair of a dam or reservoir, the DSOD makes continuous or periodic inspections to verify that construction is proceeding in accordance with approved plans.

California Building Code

The California Building Code (CBC) has been codified in the California Code of Regulations (CCR) as Title 24, Part 2, which is a portion of the California Building Standards Code. The California Building Standards Commission is responsible for coordinating building standards under Title 24. Under state law, all building standards must be centralized in Title 24 or they are not enforceable. The purpose of the CBC is to provide minimum standards to safeguard property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of building and structures within its jurisdiction. The Uniform Building Code (UBC), published by the International Conference of Building Officials, is a widely adopted building code in the United States. The CBC is based on the 1997 UBC, with necessary California amendments. These amendments include significant building design criteria that have been tailored for California earthquake conditions. The CBC applies to all structures that require a foundation.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zone Act) signed into law in December of 1972, requires the delineation of zones along active faults in California. The purpose of the Alquist-Priolo Act is to regulate development on or near active fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones, which includes withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement (Hart and Bryant, 1997). Surface fault rupture is not necessarily restricted within an Alquist-Priolo Zone. However, the proposed and existing project sites are not located within an Alquist-Priolo fault zone and therefore, this Act is not applicable to this project.

3.5.3 Impacts and Mitigation Measures

Significance Criteria

In accordance with Appendix G of the *CEQA Guidelines*, a geologic or seismic impact is considered significant if it would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault
  - Strong seismic ground shaking
  - Seismic-related ground failure, including liquefaction
  - Landslides
- Result in substantial soil erosion or the loss of topsoil;
- Be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on-site or offsite landslide, lateral spreading, subsidence (i.e., settlement), liquefaction, or collapse;
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property;
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater;
- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state; or
- Result in the loss of availability of a locally important mineral resource recovery site delineated on a local General Plan, Specific Plan, or other land use plan.

Seismic-Related Hazards

Based on the geologic environment in the project area, the proposed project would not result in impacts associated with fault rupture, ground shaking, liquefaction, expansive soil, wastewater disposal, or mineral resources. No impact discussion is provided for these topics for the following reasons:

Fault Rupture. The faults most susceptible to earthquake rupture are active faults, which are faults that have experienced surface displacement within the last 11,000 years (35,000 years per DSOD criteria). No active faults traverse through the project site, and the nearest active fault (Casa Loma strand of the San Jacinto) is approximately 5 miles away. Therefore, the potential for fault rupture to affect the proposed project is negligible.

Ground Shaking. The purpose of the project is to improve the stability and performance of the dam in order to meet seismic safety requirements of the DSOD. Therefore, the project itself would significantly reduce the potential for injury and damage from ground shaking and is considered a beneficial impact.

Liquefaction. Soils underlying the dam embankment are susceptible to liquefaction. The project would significantly reduce this potential hazard by improving the engineering properties of the alluvial soils downstream of the dam toe and buttressing the dam with a stability berm. Therefore, the project would result in a beneficial impact. The project would not change the existing liquefaction potential resulting from elevated groundwater caused by seepage from the reservoir.

Other Geologic Constraints

Based on the geologic environment in the project area, the proposed project would not result in impacts due to expansive soil, wastewater disposal, or mineral resources. No impact discussion is provided for these topics for the following reasons:

Expansive Soil. The project would not cause a potential risk to life or property due to the absence of expansive soils. The embankment fill would be reconstructed using the existing embankment materials and materials excavated from the lakebed and borrow area. The fill used for the new embankment would be compacted and engineered under the supervision and approval of the DSOD. By adhering to the engineering specifications required by the DSOD, the effects of expansive soils, if present, would be minimized. Therefore, there is no impact associated with this hazard.

Wastewater Disposal. None of the project elements require the use of septic or other alternative disposal wastewater systems, and therefore no impact associated with this hazard would result.

Mineral Resources. No designated Mineral Resource Zones would be affected by the proposed project. The borrow area would be located within the inundation area of the lake. The stability berm would be located at the toe of the dam. Neither of the emergency outlet extension alternatives would affect access to designated mineral resources. There would be no conflict with mineral extraction interests.

Unstable Soils and Geology

Impact 3.5-1: Earthwork activities could create areas with unstable slopes associated with the existing embankment and the former rock quarry area.

The proposed project includes significant earthwork and grading activities during construction. The toe of the existing dam would be removed in order to access the liquefiable alluvium in the treatable portion of both the foundation soils and the soils comprising the berm foundation downstream of the dam. Excavation activities are also proposed for the construction of the new outlet tower and for both emergency outlet extension alternatives (though the aboveground alternative would require less excavation as compared to the underground alternative). In addition, further excavation in the amount of approximately 800,000 tons of rock from the existing rock quarry in the Bernasconi Hills for the stability berm would be required. Earthwork associated with the borrow area in the eastern end of the lake would also be required. No slope instability associated with work in the borrow area in the lake would occur. Some minor slope failures associated with the excavated embankment are possible.

The findings of the slope stability analysis of the dam following the effects of liquefaction indicated the potential for instability of the embankment causing deformations and potential overtopping (DWR, 2005). The project would significantly reduce this potential hazard by improving the liquefiable soils, recompacting the toe of the foundation, and constructing a stability berm at the downstream toe of the dam, all subject to DSOD oversight and approval. This engineered improvement of both the foundation and the downstream berm soils would ultimately reduce the potential for slope instability to less than significant levels. However, implementation of Mitigation Measure 3.5-1a would ensure that slope stability impacts are reduced to less than significant levels throughout construction.

The quarry area has remained essentially off-limits to visitors since the opening of the park. Reopening the quarry for hard-rock mining would require ensuring stability of the existing rock faces. Reactivating the quarry would require that DWR comply with mining regulations that establish slope and rock stability requirements. Occasional minor wedge failures may occur within the rock quarry. The new mining activity would provide for re-contouring parts of the existing quarry to ensure compliance with mine safety regulations.

Mitigation Measures

Mitigation Measure 3.5-1a: During the final design phase of the project, DWR shall perform a design-level geotechnical evaluation to ensure the function of the stability berm. The geotechnical evaluation shall prescribe measures to mitigate hazards associated with excavation of the existing embankment. Slope stabilization measures may be identified including slope inclination, CDSM depths and locations, fill compaction, soil reinforcement, surface and subsurface drainage facilities, temporary shoring, and erosion control measures. These measures shall consider the long-term stability of the disturbed areas following construction activities.

Mitigation Measure 3.5-1b: Prior to re-activating the quarry, DWR shall conduct a geotechnical evaluation of the quarry and provide recommendations to stabilize the quarry walls. Recommendations will include at a minimum the following, in conformance with hard rock mining and worker safety regulations:

- Side wall contouring requirements
- Shoring requirements
- Stabilization requirements
- Rock-fall protection mechanisms

Significance after Mitigation: Less than Significant.

Soil Erosion

Impact 3.5-2: Exposure of soils to erosion and loss of topsoil during construction activities related to excavation of existing embankment, soil stockpile management, outlet tower construction, and emergency outlet extension construction.

Significant quantities of soils would be excavated, stockpiled, and transported as part of the proposed project. The stability berm would require approximately two million cy of material to construct which would be taken from several sources in the area. The outlet tower replacement would require excavation of 19,000 cy of soil and rock. The underground emergency outlet extension alternative would require excavation of over 327,000 cy of mostly soil. The open channel emergency outlet extension alternative would require excavation of approximately 600,000 cy of soil. If unmanaged, erosion could cause the loss of topsoil or undermine access roads. The impact would be less than significant with implementation of the following mitigation measure.

Mitigation Measures

> **Mitigation Measure 3.5-2:** DWR shall incorporate into contract specifications the requirement that the contractor(s) develop and implement an erosion control plan, in addition to implementing requirements for preventing storm water pollution from construction activities as required by the Storm Water Pollution Prevention Plan (SWPPP). These requirements include developing and implementing erosion control measures for all construction activities including the following:
>
> - Slope stabilization measures
> - Haul road surface maintenance
> - Wind erosion protection measures for stockpiled soil
> - Storm water runoff control for all construction areas
> - Post construction restoration plans
>
> The final reclamation plan for the borrow area and rock quarry shall include drainage improvements to minimize erosion potential. Regular maintenance of the disturbed areas and stockpiled materials shall also be included in contract specifications for the contractor(s).

Significance after Mitigation: Less than Significant.

Subsidence

Impact 3.5-3: Stockpiled materials from excavation of the embankment could cause subsidence of native materials underneath.

Some of the soil excavated from the dam toe area and/or the borrow area would be stockpiled nearby for reuse in reconstruction of the foundation and berm. Depending on the size of the stockpiles and the nature of the underlying materials, though highly unlikely, there is a potential for near surface settlement of the ground surface underneath the stockpiles. The impact would be less than significant with implementation of Mitigation Measure 3.5-1a, and the following mitigation measure.

Mitigation Measures

Mitigation Measure 3.5-3: The geotechnical evaluation shall include a review of the surface and near-surface materials in the areas where materials will be stockpiled. The evaluation shall determine if the underlying materials have adequate short-term strength to support the proposed stockpiles and, if not, shall provide recommendations to avoid this hazard. The recommendations shall be incorporated into contract specifications for the contractor(s). Recommendations could include reducing the size of the stockpiles, increasing the number of stockpiles, and finding alternative locations for stockpiles.

Significance after Mitigation: Less than Significant.

Mitigation Measure Summary Table

Table 3.5-2 presents the impacts and mitigation summary for Geology, Soils, Faulting and Seismicity.

TABLE 3.5-2
GEOLOGY, SOILS, FAULTING AND SEISMICITY IMPACTS AND MITIGATION SUMMARY

Proposed Project Impact	Mitigation Measure	Significance after Mitigation
Unstable Sloping: Earthwork activities could create areas with unstable slopes associated with the existing embankment and the former rock quarry area.	3.5-1a and 3.5-1b	Less than Significant
Erosion: Exposure of soils to erosion and loss of topsoil during construction activities related to excavation of existing embankment, soil stockpile management, outlet tower construction, and emergency outlet extension construction.	3.5-2	Less than Significant
Foundation Subsidence: Stockpiled materials from excavation of the embankment could cause subsidence of native materials underneath.	3.5-3	Less than Significant